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(54) ELECTRICAL POWER GENERATING UNITS

(71) We, BATTELLE-INSTITUT e.V., A German body corporate, of Am Romerhof 35, 6000 Frankfurt/Main 90, Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to electrical power generating units.

Electrical power generating units comprising a combustion engine, a drive mechanism and a generator are available in many different designs for providing non-system dependent power supplies, including emergency power supplies. The driving engine and generator are usually separated from each other. The engines employed are generally internal combustion engines, e.g. Otto or diesel engines. However, external combustion engines, e.g. Stirling engines, are also known to have been used. used.

A disadvantage of internal combustion engines is that they are of bulky construction which occupies a lot of volume and is very heavy. In addition, structure-borne and air-borne noise emission is rather high. Other disadvantages are their unfavourable exhaust gas composition and relatively low efficiency. Less structure-borne and air-borne noise, cleaner exhaust gas composition and better efficiency may be expected if external combustion engines are used, but the disadvantage of the large constructional volume and high weight remains a problem.

According to the invention an electrical power generating unit comprises a multi-cylinder Stirling gas engine having double-acting pistons, a rotary-piston drive mechanism having an output drive shaft, liquid columns connecting the double-acting pistons to the rotary-piston drive mechanism, and a generator having a rotor upon which the output drive shaft acts directly, the rotor being constructed as a hollow cylinder within which the rotary-piston drive mechanism is installed.

In a preferred electrical power generating unit embodying the invention and described in more detail below, the engine, drive mechanism and generator are integrated to form a compact unit. This was made possible by employing the Stirling engine with the rotary-piston drive mechanism and especially by the design of the generator, which makes it possible to install the drive mechanism in a hollow axle of the rotor. Advantages resulting from the choice and combination of the individual parts mentioned and the special design of the preferred unit are its compact design, its relatively low total weight, its high efficiency and its relatively clean exhaust emission.

The preferred unit includes a heat exchanger arranged to be warmed by exhaust gases of the Stirling engine and a blower, the blower being connected to the output drive shaft so that, in use, it draws in air which is first used to cool the generator and then directed via the heat exchanger directly into a combustion chamber of the Stirling engine. This arrangement contributes to the high overall efficiency of the unit because the energy required for preheating the combustion air is supplied in part through the heat loss produced by the operation of the generator and in part

via the exhaust gases of the engine. In addition, the efforts to achieve a compact design are aided by directing the cooling and combustion air in the manner described.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of the unit; and

Figure 2 shows further details, but still in diagrammatically simplified form, of the unit shown in Figure 1.

Figure 1 shows an electrical power generating unit comprising a multi-cylinder Stirling gas engine 1, a rotary-piston drive mechanism 3, and a generator 5. An axle 2 of a rotor 4 of the generator 5 is designed as a hollow cylinder within which the rotary-piston drive mechanism 3 is mounted, approximately half of the hollow space being filled by the drive mechanism 3. The path of air drawn in which first serves as cooling air for the generator 5 and then as combustion air for the engine 1, is denoted by the arrows in Figure 1.

Further details of the generating unit are shown in Figure 2. The multi-cylinder Stirling gas engine 1 has double-acting pistons 10, one of which can be seen in Figure 2. The power from the pistons 10 is transmitted to the rotary-piston drive mechanism 3 via liquid columns 11, while an output drive shaft 12 of the drive mechanism 3 acts directly upon the rotor 4 of the hollow-axle generator 5.

The energy generated in an external combustion chamber 8 of the Stirling engine 1 is passed to the working medium of the Stirling engine via a heat exchanger 9, which causes the pistons 10 to move in axial directions. The energy of the pistons 10, as described earlier, is transmitted to the drive mechanism 3 via the liquid columns 11 and then directly to the generator 5; for this purpose the output drive shaft 12 is connected to the rotor 4.

A bearing 13 which supports the rotary piston drive mechanism 3, together with a support bearing 14 installed in an end wall of the generator 5, support respective ends of the output drive shaft 12 and therefore support the rotor 4 of the generator. Using the relatively high precision rotary-piston bearing 13 with its limited play additionally as a rotor bearing provides an air gap between the rotor 4 and the stator, which helps to reduce losses and increase efficiency.

A blower 6 is connected to the output shaft to draw in air to cool the generator 5. After cooling the generator 5 and therefore being warmed, the air is passed via a duct 7 to an exhaust gas heat exchanger (not shown), where it is further warmed by the exhaust gases of the engine 1. The air, heated both by the generator 5 and in the exhaust gas heat exchanger, is then conducted directly into the combustion chamber 8 of the engine 1.

The generator 5 in the illustrated embodiment of the invention is a disc-shaped internal-pole three-phase synchronous generator with a hollow rotor axle 1. The hydrostatic rotary-piston drive mechanism 3 is, as explained, built into the interior of the hollow rotor axle 2. The generators are excited in a brushless manner by a directly attached exciter 15. The exciter 15 can be designed so that it can function also as a starter for the generating unit. Multi-phase rectification of the output of the generator 5 can be employed to generate direct current.

Instead of the three-phase generator 5 described, it is in principle possible to use instead a direct-current generator with a commutator. The necessary space for the commutator could be provided by shortening the hollow axle 2.

WHAT WE CLAIM IS:

1. An electrical power generating unit comprising a multi-cylinder Stirling gas engine having double-acting pistons, a rotary-piston drive mechanism having an output drive shaft, liquid columns connecting the double-acting pistons to the rotary-piston drive mechanism, and a generator having a rotor upon which the output drive shaft acts directly, the rotor being constructed as a hollow cylinder within which the rotary-piston drive mechanism is installed.

2. An electrical power generating unit according to claim 1, wherein the rotary-piston drive mechanism and an end of the output drive shaft are supported by a common bearing.

3. An electrical power generating unit according to claim 1 or claim 2, which includes a heat

exchanger arranged to be warmed by exhaust gases of the Stirling engine and a blower, the blower being connected to the output drive shaft so that, in use, it draws in air which is first used to cool the generator and then directed via the heat exchanger directly into an external combustion chamber of the Stirling engine.

4. An electrical power generating unit substantially as herein described with reference to the accompanying drawings.

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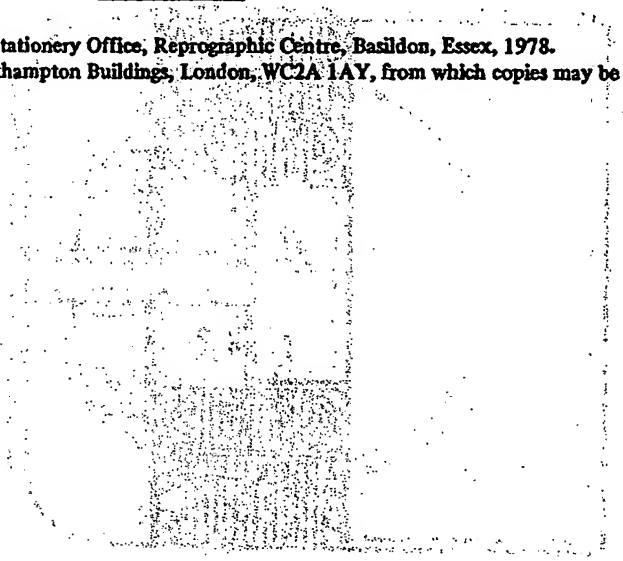

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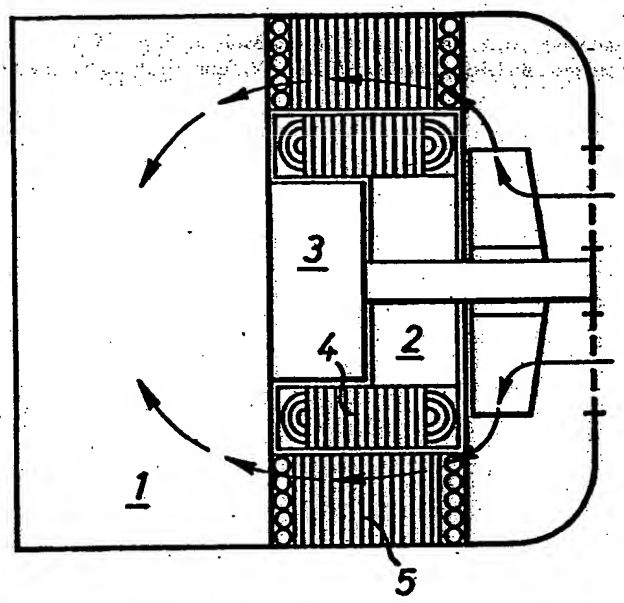

FIG.1

1 528 714 COMPLETE SPECIFICATION
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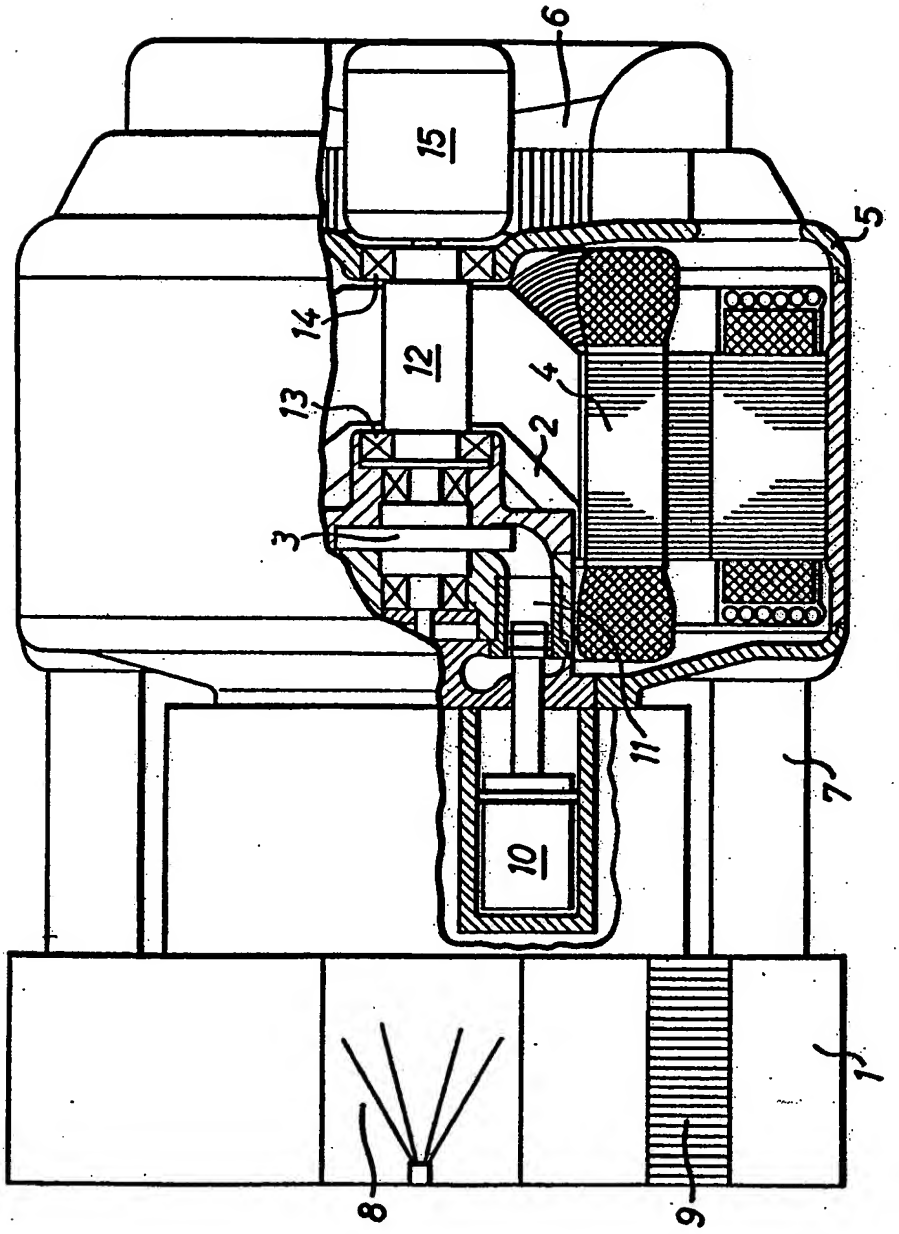
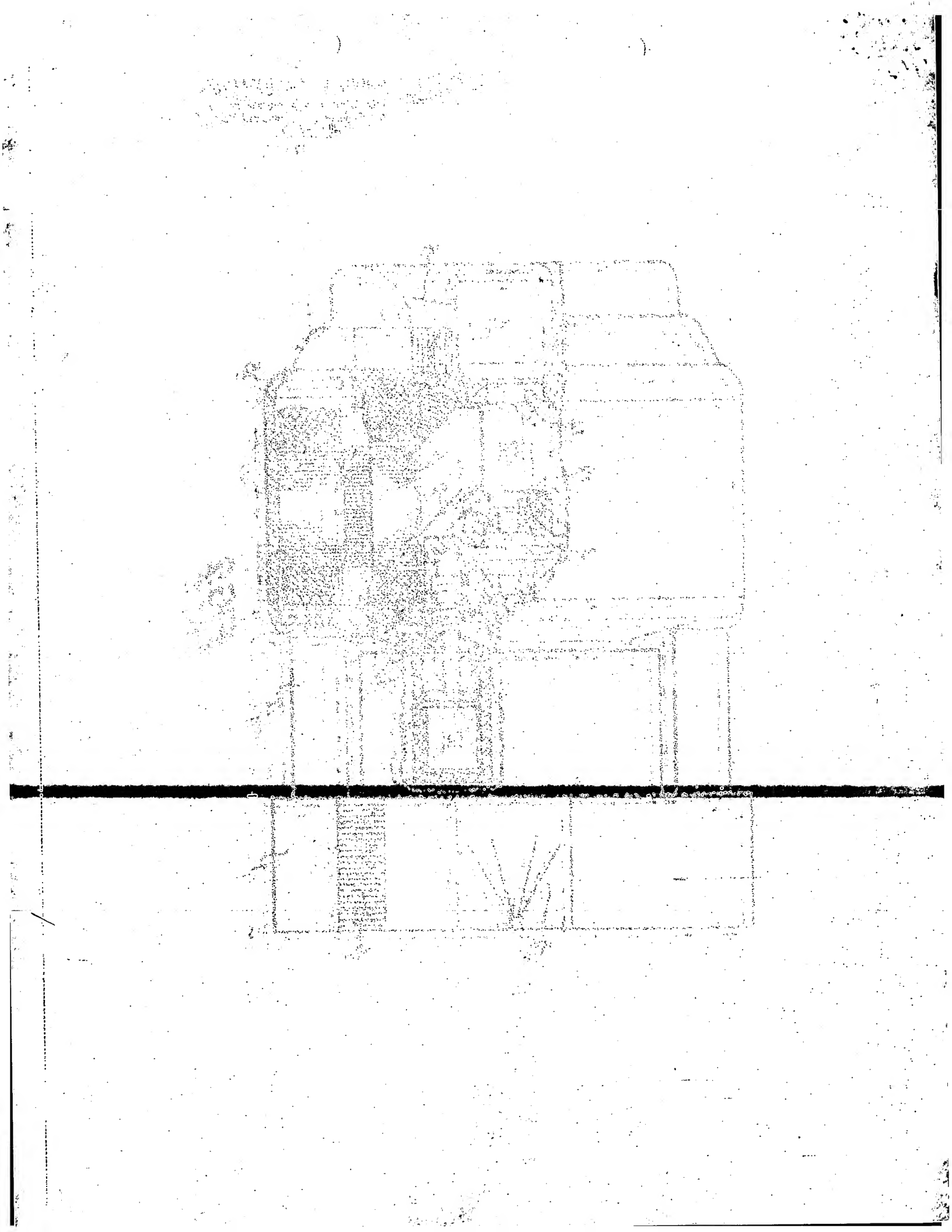


FIG.2



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SHEET 1

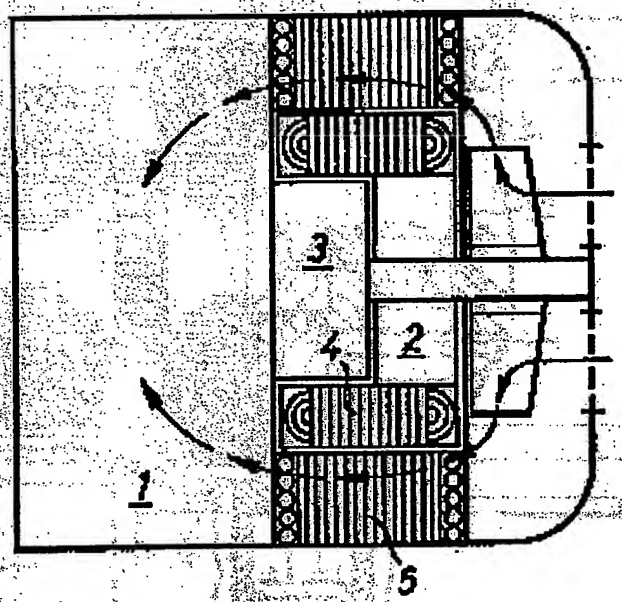

FIG.1

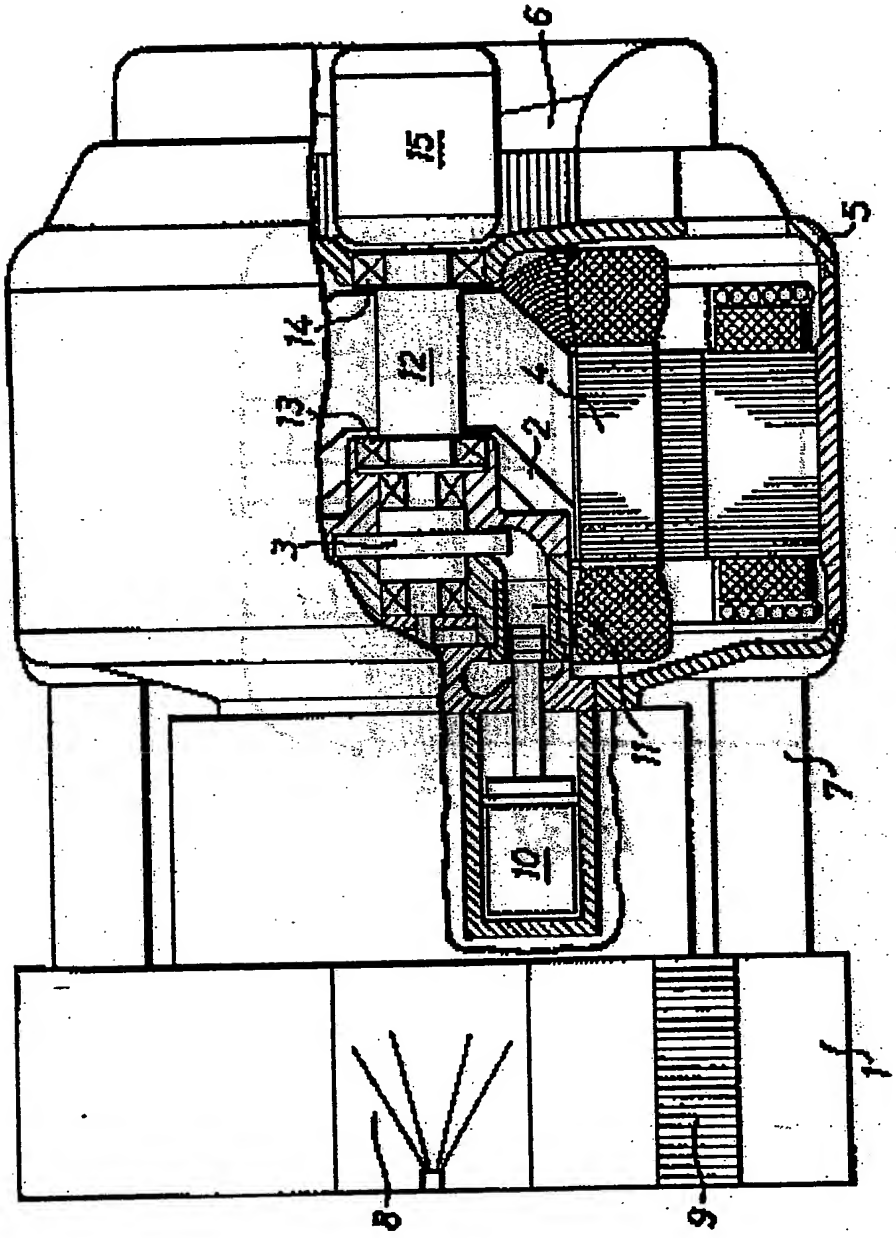

FIG.2